TROPICAL NUMERICAL PREDICTION

Dr. T.N. Krishnamurti
Florida State University
850-644-2210
tnk@met.fsu.edu

N00014-95-1-1132

LONG TERM GOALS

Improvement of high resolution ensemble modeling of hurricanes. This modeling effort utilizes a hierarchy of models: a) a global model that provides lateral boundary conditions and the base state for a regional spectral model, b) a high resolution global model that provides physical initialization, i.e. the initialization of the initial rain rate from an assimilation of the observed rainfall from satellite and SSM/I data sets, and c) a regional spectral model that provides a high resolution ensemble forecast. The ensemble forecast utilizes an EOF based perturbation generation strategy. Ensemble averaging based on several techniques are being used presently. This system is naturally designed for strategies of adaptive observations towards improving observations, assimilation and hurricane forecasts.

OBJECTIVES

The main objective of this approach is to develop an advanced method of ensemble forecasting over the tropics that can improve the predictability of tropical weather systems such as monsoons, tropical waves and depressions, hurricanes, typhoons and the overall tropical weather elements. Adaptive observational strategies being developed here will assist in the design of future field experiments by providing guidance for the design of observing systems such as research and operational aircraft missions and for the extraction of very high resolution satellite based data sets. This work is supported by the ONR Marine Meteorology Program.

APPROACH

The research approach consists of a data collection phase, a data assimilations phase, where rain rate initialization has a very important role. The global model provides the base states for the regional spectral model and the ensemble forecasts at very high resolution. This is followed by an ensemble averaging which is done in three different ways, a) to perform a straight ensemble average or b) to exclude outliers and those that perform poorly in the first 12 hours of forecast (observations would be available for those by the time the entire forecast process is complete) or c) to invoke a cluster averaging technique which we have developed. Finally, we asses the forecast and also pursue an adaptive observation inquiry where we make use of probability density functions from the results of the ensemble.

Report Documentation Page	*Form Approved* *OMB No. 0704-0188*

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
30 SEP 1997		**00-00-1997 to 00-00-1997**

4. TITLE AND SUBTITLE **Tropical Numerical Prediction**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Florida State University,Tallahassee,FL,32306-4320**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR’S ACRONYM(S) 11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

WORK COMPLETED

One of the most successful aspects of the work completed is on the intensity forecasts for hurricanes OPAL of 1995 and FRAN of 1996. The diagram of the angular momentum and of the potential vorticity was most revealing for hurricane OPAL. We found that descending air behind the mid-latitude trough as it enters the storm circulation undergoes a reduction of the radial gradient of angular momentum of incoming parcels. That contributed to an enhancement in the intensity of OPAL. Another area of research on hurricane intensity was a study of the angular momentum budget for these predicted storms along lower tropospheric inflow channels. We find a relative lack of cumulus convection along the inflow channels contributed to less of a loss of angular momentum by deep convection, thus making it possible for parcels to move in carrying high values of outer angular momentum that resulted in an enhancement of the storm intensity.

RESULTS

We have developed a regional spectral high-resolution model within a global model (one-way nested) with the capability to carry our ensemble forecasts. Our research has addressed the intensity issue of hurricanes with angular momentum and potential vorticity as a frame of reference. Results show that diabatic PV interactions are extremely important for the diagnosis of storm intensity. When reasonable forecasts are obtained such as for Hurricanes OPAL (1995) and FRAN (1996), we noted that a reduction of the gradient of angular momentum of inflowing parcels occurs, resulting in an intensification of these storms. That is directly related to a diabatic PV effect on the potential vorticity of inflowing parcels. In the lower tropospheric inflowing channels a relative absence of deep convection also results in the penetration of high angular momentum air from the storms interior leading to the intensification of these storms to category three.

IMPACT

This study has implications for the interpretation and prediction of hurricane intensity forecasts. Our group has been one of the first to emphasize the importance of diabatic potential vorticity contributions for the intensification of a hurricane.

TRANSITION

This study reflects a major transition from straight high resolution global modeling towards higher resolution, one-way nested, regional modeling. The other major transition, reflected in our research, is the implementation of the ensemble forecast strategy for hurricane track forecasts.

RELATED PROJECTS

NASA Project entitled "Initialization and High Resolution Global Prediction using PR and TMI Data from TRMM"

NSF Project entitled "Sensitivity of Hurricane Prediction to Initial Perturbations and Physical Initialization"

REFERENCES

Krishnamurti, T.N., W. Han, B. Jha and H.S. Bedi, 1997: Numerical Prediction of Hurricane Opal. Monthly Weather Review, Nov. issue.

Zhang, Z. and T.N. Krishnamurti, 1997: On Ensemble Forecasting of Hurricane Tracks, accepted for publication, Bull.Amer.Meteor.Soc.